ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Digital Data Transmission within	)	RM-7567
the Video Portion of Television	)	
Broadcast Station Transmissions	)	

COMMENTS OF COMSAT CORPORATION

COMSAT Corporation ("COMSAT"), herein submits its Comments in response to the Federal Communications Commission's Notice of Proposed Rulemaking (Notice) in the above-captioned proceeding.

The Commission initiated this rulemaking proceeding to determine the best means of permitting digital data to be integrated with the current television broadcast service. COMSAT has reviewed both methods proposed for insertion of digital data into the video portion of an NTSC signal -- the overscan method and the sub-video method. COMSAT is generally supportive of efforts to increase the efficiency of spectrum utilization and the resultant benefits to users. However, care must be taken to avoid unintended effects that may occur in transmission over media such as satellites or wireless cable that may use digital, rather than analog, modulation. The proponent of each method should bear the primary responsibility of testing its proposals under these and other conditions outside of conventional analog

broadcasting.

Overscan Data Insertion

Nielsen and Yes! Entertainment Corporation have proposed use of line 22, the first line of active video, or portions of other lines of active video that are outside of normal scanning areas for data insertion. Several questions are raised in the Notice concerning these approaches. COMSAT believes that the use of satellite transmission techniques, including digital compression, is compatible with these techniques. Thus, provided no other problems are identified, COMSAT has no objection to using these techniques for data insertion.

Sub-Video Data Insertion

Both WavePhore, Inc. (WavePhore) and Digideck, Inc. (Digideck) have proposed the use of digital data insertion in the active video area of an NTSC signal, techniques which can be denoted as sub-video methods. Both have claimed that the amplitude of the inserted signal for digital data services is low enough so that no discernible degradation will be noticed by most viewers. However, we believe that the use of such sub-video methods may cause picture quality degradation when the TV signal with sub-video insertion is processed by a digital compression methodology, including the MPEG-2 standard. In the near future, we expect to see digital video compression employed in many TV

distribution networks. Also, in a few years, consumer digital VCRs may become available for recording off-the-air TV programming. Therefore, any potential picture quality degradation caused by data insertion in the active video area will affect the viewing pleasure of large segments of the general public.

Potential Impact of Sub-Video Data Insertion on Digital Video Compression

In order to understand why sub-video data insertion may cause picture quality degradation of compressed digital video, it is necessary to examine the techniques behind compressed digital video. Today, the most publicized and internationally accepted video compression algorithm is MPEG (Moving Picture Experts Group). The MPEG-1 standard was finalized a few years ago with primary applications in CD-movies at a rate of about 1.5 Mbps. The recently adopted MPEG-2 is intended for much wider applications ranging from high-quality video distribution at 15 Mbps or above, to other uses, such as DBS and distance learning, at rates as low as 1.5 Mbps. Key techniques used in MPEG compression are motion estimation and discrete cosine transform (DCT). In addition, all compression algorithms quantize the analog video into digital video. In the following sections, we will address the potential impact of sub-video data insertion on each of these aspects.

Effect on Quantized Digital Video

The signal level corresponding to the inserted ancillary data could be as high as several IRE units according to WavePhore's and Digideck's information. In an MPEG-based system, as well as most other digital video systems, the video is quantized into 8 bits (220 gray levels for 100 IRE units in the CCIR 601 standard). Therefore, 1 IRE unit is mapped to approximately 2 gray levels. If the amplitude of data inserted is 3 IRE units, the corresponding quantized gray level may be altered by 6 or 7 levels - which seems to be significant from a digital coding point of view.

Effect on Motion Estimation

In both MPEG standards, the P-type (predictive) picture is transmitted by coding the differences between the current picture and the previous picture. The compression efficiency can be greatly improved by taking into account the movement of objects in the picture. This may be accomplished though the motion estimation technique. The motion estimation technique adopted in the MPEG standard is called block matching algorithm (BMA). The algorithm will match corresponding 16 x 16 blocks in two consecutive pictures by searching through an area (called search window) around the current location. The best match is often defined as the location that achieves the minimum mean square

error between the current block and the displaced block in the previous picture.

In a hypothetical case of a still scene captured by a camera undergoing a pan motion, two consecutive pictures should be spatially shifted duplicates of each other, assuming no noise. In this case, a perfect match can always be found for all blocks (except for boundary blocks). Therefore, the difference signal between the corresponding blocks is zero and the coding efficiency is extremely high since there is nothing to code in the motion-compensated differences. However, when the sub-video signal is inserted, a perfect match can no longer be found. The accuracy of motion estimation will be affected by data insertion since the data inserted acts as noise. In turn, the coding efficiency of the system will be affected by the reduced accuracy of motion estimation.

Based on our experience with digital video coding, data insertion will definitely cause some coding inefficiency, which manifests as picture quality degradation. In a situation where data insertion is repeatedly made to a TV signal by others in addition to the local broadcaster, the degradation would be even worse due to the cumulative effect of sub-video signals. The degree of severity of picture quality degradation due to single or multiple data insertions and their effects on motion estimation is subject to more studies and computer simulation to

assess a numerical impact.

Effect on DCT

The DCT technique has been widely used in many digital image/video compression algorithms due to its high compression efficiency. The 8 x 8 DCT is used in MPEG which is applied to 8 x 8 blocks of the original picture (the I-pictures) or the motion compensated difference picture (the P- or B-picture). The DCT data of typical I-blocks is very much skewed toward the low-frequency corner (viewing the DCT data as a two-dimensional spatial frequency response). This property makes DCT very efficient for compression since it packs most information into the low-frequency region. A similar feature is also observed on the P- and B-blocks. Sub-video data insertion will add noise, in essence, to the underlying TV signal, which will increase the information content in the high-frequency region. This spread of DCT data into the high-frequency region implies lower compression efficiency and consequently lower picture quality. The precise degree of quality degradation on DCT also needs to be assessed through more studies and computer simulations.

Conclusion

COMSAT believes that the use of satellite transmission techniques, including digital compression, are compatible with

the use of overscan data methodologies. However, we believe that sub-video signals have the potential to cause noticeable picture quality degradation when the TV signal with the sub-video data insertion is subject to further processing, such as quantization and compression. At this time, proponents of sub-video data insertion have not demonstrated its compatibility with digital modulation and compression schemes. Accordingly, proponents of sub-video techniques should perform additional studies and testing and submit their results to the Commission for inclusion into the record in this proceeding. The parties and the Commission could then review these submissions based on actual test data and our own experience. Because of the problems identified above, COMSAT believes the Commission must remain actively engaged in the process of regulating compatibility standards and insertion methodologies. In this regard, the Commission should adopt a comprehensive set of rules relating to insertion of digital data into the video portion of NTSC signals, rather than authorizing such transmissions on an ad hoc basis. This will promote the public interest as well as result in cost

savings to COMSAT and other carriers of television transmissions, who may have to remove this data prior to further processing in order to avoid unacceptable picture quality degradation.

Respectfully submitted,

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